STRUCTURAL - FUNCTIONAL ANALYSIS OF THE SOIL LEVEL MACHINE

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Abstract: *The soil leveling machine is of half – carried type and it works, as unit, with the wheeled tractor (or caterpillar tractor). The leveling plane is established by the rear wheels of the tractor and by the wheels of the hind train of the machine. The positive and negative soil dislevelments are given against the leveling plane. In the paper there are established the displacements of the mechanism for the automatic working regime, in which the cutting blade is execution element.*

1. Introduction

MNS soil leveling machine 3.2. is of the semi-trailed type and works in aggregate with the tractor on wheels (or tracks). During work, the machine and the tractor are rigid in the vertical plane - logically, so that the leveling plane is determined by the rear wheels of the tractor and the wheels of the rear train of the machine. In relation to this plan there are positive or negative gaps that are flattened by the automatic leveling mechanism (fig.1).

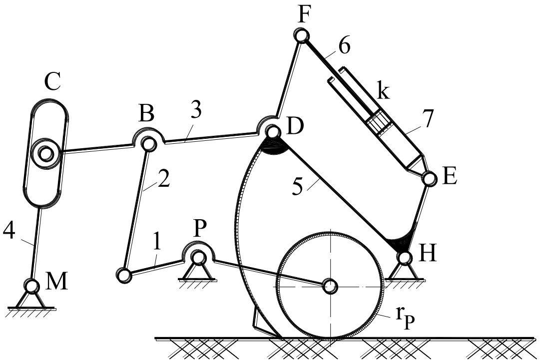

Fig.1

2. Structural parameters of the mechanism

The mechanism has two degrees of mobility. A degree of mobility is given by the translational motor coupling K (6,7) which ensures the position of the cup blade in relation to the plane of leveling - initial adjustment and the second degree of mobility corresponds to the vertical displacement of the throttle wheel and provides the signal of input for automatic operation - automatic adjustment. The two sequences are independent.

Adjusting the position of the blade blade in relation to the leveling plane is performed during the stationary phase of the unit. The palpable wheel keeps the contact with the ground so that its immobility also implies the immobility of the element 1. Ensuring the operation of the mechanism in automatic mode (in the second sequence) impedes the positioning of the rotation translation coupling C to the average position of the displacement and the cancellation of the translational movement (transformation into the coupling rotation).

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The configuration of the elements and couplings identified for this sequence is highlighted in the structural diagram (fig. 2). Elements of contours I and II form a rigid construction with zero mobility. Cancellation of overconstrations is possible only by cutting the element 2, so that for each initial setting step it is also necessary to adjust the length of the element 2 (by the screw coupling).

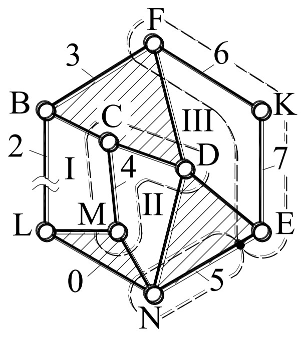

Fig.2

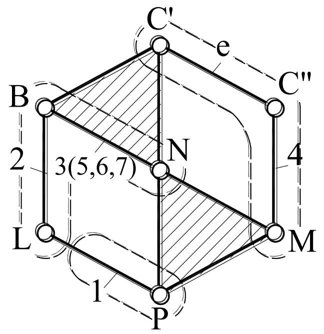

Fig.3

The automatic operation of the mechanism consists in taking the signal from the touch wheel to the element 1 and then transmitting it to the execution element (the leveling blade blade) whose relative position relative to the leveling plane was set in the initial adjustment sequence .The mechanical - hydraulic system (cylinder - piston) remains in a locked position, which causes the rotation coupler D (3,5) to be canceled, the elements 3 and 5 being transformed into a single element. To ensure that the mechanism is dismodomed, the rotation translation C (3,4) is reconsidered.The configuration of the elements and the couplings corresponds to the structural diagram of fig. 3.

3. The geometric synthesis of the mechanism

The palpable wheel copies the ground with negative or positive displacements relative to the leveling plan [4]. On these displacements, the execution element lowers and rises, respectively, by performing the cutting of the gaps and respectively the covering of the negative gaps. Faced with the neutral position (the touch wheel is in the leveling plane), the control element must be secured with equal positive and negative displacements.

The synthesis corresponds to the initial phase of the bow blade adjustment relative to the neutral plane. Both the relative displacements in the motor coupler (of the piston relative to the cylinder) and the dimensions of the element 2 are determined.

The positional parameters are identified on the kinematic scheme (fig. 4).

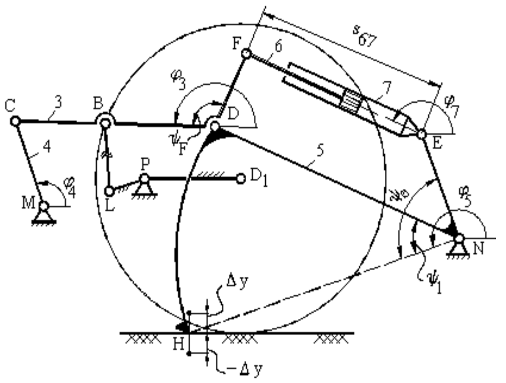

Fig.4

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A. Positioning parameters of the execution element.

The cup blade is positioned vertically by the coordinate

$y_H = y_H^0 \pm K\Delta y$

Where y_H^0 is coordinated in the neutral position;

K - a positive constant K = 0,1,2,3, ...

Δy the size of the adjustment step

From the relationship $y_H = y_N + 1_{NH} \sin\varphi_5$

is determined $\varphi_5 = \arcsin \dfrac{y_H - y_N}{1_{NH}}$

B. Positional Parameters on Diada Elements 3.4

The coordinates of the potential couplers are determined.

$X_M = C_1 \; y_M = C_2$

$X_D = X_N + 1_{ND}\cos(\varphi_5 - \psi_D) \qquad y_D = y_N + 1_{ND}\sin(\varphi_5 - \psi_D)$

From diada equations

$$X_M + 1_{MC}\cos\varphi_4 - X_D - 1_{DC}\cos\varphi_3 = 0$$

$$y_M + 1_{MC}\sin\varphi_4 - 1_{DC}\sin\varphi_3 = 0$$

positional parameters are determined φ_4 and φ_3

$$\varphi_4 = \arccos\frac{AC \mp B\sqrt{A^2 + B^2 - C^2}}{A^2 + B^2} \qquad \varphi_3 = \arccos\frac{X_M - X_D + 1_{MC}\cos\varphi_4}{1_{DC}}$$

where: $A = 21_{MC}(X_M - X_D)$; $B = 21_{MC}(y_{MC} - y_D)$

$$C = 1_{DC}^2 - 1_{MC}^2 - (X_M - X_D)^2 - (y_M - y_D)^2$$

The position of the coupling B is given by the coordinates:

$X_B = X_D + 1_{DB}\cos\varphi_3$; $\qquad y_B = y_D + 1_{DB}\sin\varphi_3$

The length of element 2 is determined by the relationship $1_{LB} = \sqrt{(X_B - X_L)^2 + (y_B - y_L)^2}$

C. Positioning parameters for diada elements 6,7.

The coordinates of the potential couplers are determined:

$$X_F = X_D + 1_{DF}\cos(\varphi_3 - \psi_F);\; y_F = y_D + 1_{DF}\sin(\varphi_3 - \psi_F)$$

$$X_E = X_N + 1_{ND}\cos(\varphi_5 - \psi_D);\; y_E = y_N + 1_{ND}\sin(\varphi_5 - \psi_D)$$

From diada equations

$$X_E + s_{67}\cos\varphi_7 - X_F = 0$$

$$y_E + s_{67}\sin\varphi_7 - y_F = 0$$

positional parameters are obtained s_{67} and φ_7

$$s_{67} = \sqrt{(y_F - y_E)^2 + (X_F - y_E)^2}\,; \qquad \varphi_7 = arctg\frac{y_F - y_E}{X_F - X_E}$$

By choosing $\Delta y = 50$ mm, the linear displacements s_{67} and the length of the element 2 were obtained based on a calculation program whose values are given in Table 1.

Table 1

k	y_{H5}	S_{67}	H_{LB}
0	0	667,3312	269,9922
1	50	687,7474	295,5487
2	100	706,3379	321,6319
3	150	723,3647	348,0090
4	200	739,1714	374,1020
1	-50	644,7073	245,1455
2	-100	619,4387	220,9712
3	-150	590,9642	197,2258
4	-200	559,5637	172,2357

4. Moving analysis in automatic adjustment.

Determining the displacement of the execution element (the leveling blade blade) includes as inputs the positive and negative movements of the touch wheel. A reference position is admitted as the position set in the initial adjustment sequence. The computation algorithm is compatible with the Modular Group Connection Scheme [4]. Positioning parameters are identified on the kinematic scheme of Fig.5.

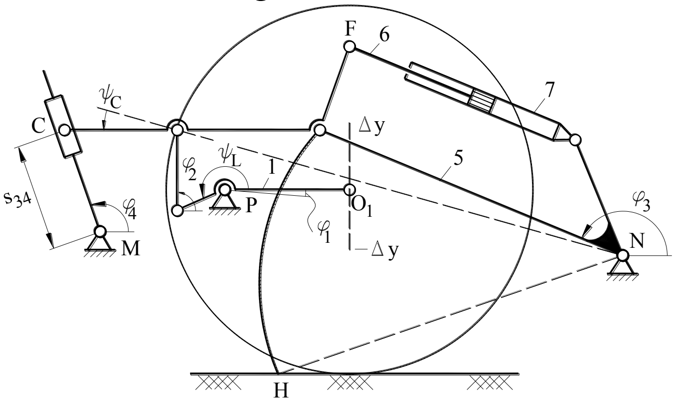

Fig.5

A. Positioning parameters on the driving element.

The touch probe wheel is positioned vertically by the coordinate

$y_O = y_O^0 + f$ where y_O^0 is coordinated to the center of the wheel in the neutral position;

f = 0 function generated by the shape and dimensions of positive or negative gaps.

From the relationship:

$y_O = y_p + 1_{PO1} \sin \varphi_1$

the movement is determined $\varphi_1 = \arcsin \dfrac{y_0 - y_p}{1_{PO1}}$

B. Positional parameters for diada 2.3

The coordinates of the potential couplers are determined

$$X_N = C_1; \qquad y_N = C_2$$

$$X_L = X_p + 1_{PL} \cos(\varphi_1 + \psi_L); \quad y_L = y_p + 1_{PL} \sin(\varphi_1 + \psi_L)$$

From diada equations:

$$X_L + 1_{LB}\cos\varphi_2 - X_N - 1_{NB}\cos\varphi_3 = 0$$

$$y_L = 1_{LB}\sin\varphi_2 y_N - 1_{NB}\sin\varphi_3 = 0$$

positional parameters are obtained φ_2 and φ_3

$$\varphi_2 = \arccos\frac{AC \pm B\sqrt{A^2 + B^2 - C^2}}{A + B}; \qquad \varphi_3 = \arccos\frac{(X_L - X_N) + l_{LB}\cos\varphi_2}{l_{NB}}$$

Where :

$$A = 2\ [l_{LB}(X_L - X_N)]; \qquad B = 2\ [l_{LB}(y_L - y_N)]$$

$$C = l_{NB}^2 - l_{LB}^2 - (X_L - X_N)^2 - (y_L - y_N)^2$$

C. Positional parameters for the diade elements 4.3 determine the coordinates of the potential couplers:

$$X_M = C_1; \quad y_M = C_2$$

$$X_{C_3} = X_D + 1_{DC}\cos(\varphi_3 + \psi_C); \quad y_{C_3} = y_D + 1_{DC}\sin(\varphi_3 + \psi_C)$$

From the position equations of the diada 4, 3

$$X_M + s_{34}\cos\varphi_4 - X_{C_3} = 0$$

$$y_M + s_{34}\sin\varphi_4 - y_{C_3} = 0$$

Parameters result φ_4 and s_{34}

$$\varphi_4 = arctg\,\frac{y_{C_3} - y_M}{X_{C_3} - X_M}; \qquad s_{34} = \sqrt{(y_{C_3} - y_2)^2 + (X_{C_3} - X_M{}^2}$$

In order for the palpable wheel to withstand maximum, positive and negative displacements in absolute magnitude, it is necessary to adjust the relative displacement s_{34} in the initial phase to a mean value

$$s_{34}^0 = \frac{s_{34}^{\max} + s_{34}^{\min}}{2}$$

Considering dimensional parameters

$$s_{34} = s_{34}^{\max} - s_{34}^{\min} = 120\,mm$$

the displacements of the execution element and of the input element have been determined, being emphasized when the leveling blade is adjusted to $y = 50$ mm (fig.6).

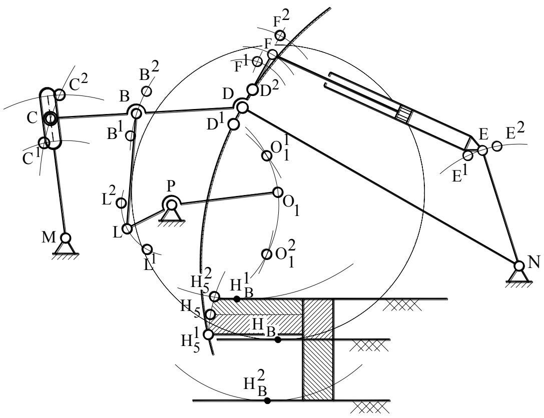

Fig.6

Conclusions:

The automatic leveling mechanism involves an initial adjustment of the blade for which it is determined the length of the element 2 and an automatic adjustment in which the movement of the execution element relative to the signal given by the touch wheel is determined. The length of the element 2 is 202 mm. Positive displacement of the touch wheel causes a lowering of the cup blade and the negative displacement causes a raise of the cup blade.

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